Sex Ratio of White Births in the United States During the Second World War

BRIAN MacMAHON AND THOMAS F. PUGH

Department of Environmental Medicine and Community Health, State University of New York, College of Medicine at New York City

and

Department of Epidemiology, Harvard University School of Public Health, Boston, Mass.

FROM EUROPEAN SOURCES there is a good deal of circumstantial evidence to support the belief that the proportion of males to females born increases during or immediately following times of war. The sex ratio increased in practically all the belligerent European countries during the First World War and in the succeeding two or three years. Complete data have not been collected for the period of the Second World War, but certainly in England and Wales a most marked increase occurred. During the years 1941–46 the English live birth sex ratio was the highest ever recorded in that country since the introduction of birth registration in 1841 (Lowe and McKeown, 1951).

No change in sex ratio was noted in the United States during the First World War (Metropolitan Life, 1939). This is hardly surprising, since, as the latter authors point out, "at most 4 per cent (of the United States population) was under arms at any time, and this only for a very short period, whereas in the principal European populations from 15 to 22 per cent were so mobilized, in most instances for the entire duration of the war." The Second World War, however, affected the social structure of the United States to almost as great an extent as some of the participating European countries, and if no change in sex ratio occurred in the United States it would certainly bring into question the validity of the generalization regarding sex ratio and war.

Two investigators have been unable to demonstrate significant variation in the sex ratio in the United States during the Second World War. They conclude respectively, that "there is no evidence in the recent experience of our country that boy babies increase significantly during war and immediate postwar periods" (Metropolitan Life, 1949), and "the sex ratio at birth does not consistently change as a direct influence of war either during the war years or immediately after" (McMahan, 1951). The sole basis for the latter statement is the alleged absence of such change in the United States during the Second World War. An assumption that variations in the sex ratio at birth may be produced by differential elimination of the sexes from the uterus in early fetal life (Lowe and McKeown, 1950), makes it quite conceivable that such varia-

Received January 25, 1954.

tions may be associated with the social upheavals which accompany war. Such an assumption does not imply that the sex ratio at conception undergoes variation, although, of course, such might be the case.

Material

Sources of data are the annual reports of birth statistics for the United States published formerly by the Bureau of Census, Department of Commerce, and latterly by the National Office of Vital Statistics, United States Public Health Service. In view of the inadequacy of reporting of Negro and other non-white births in the United States, our examination is confined to white births.

Examination of the data on white stillbirths reveals the long-term trend illustrated in figure 1. A similar trend for stillbirths in England and Wales was noted by Lowe and McKeown (1951). It is not our purpose to comment on this marked downward trend in stillbirth sex ratio but it is of interest to note that: (1) Stillbirths are grossly under-reported. The extent of this under-reporting is unknown. Baumgartner, Wallace, Landsberg and Pessin (1949) estimated that only 86% of third trimester fetal deaths occurring in New York City in 1943–45 were reported. Since New York City is one of the more satisfactory

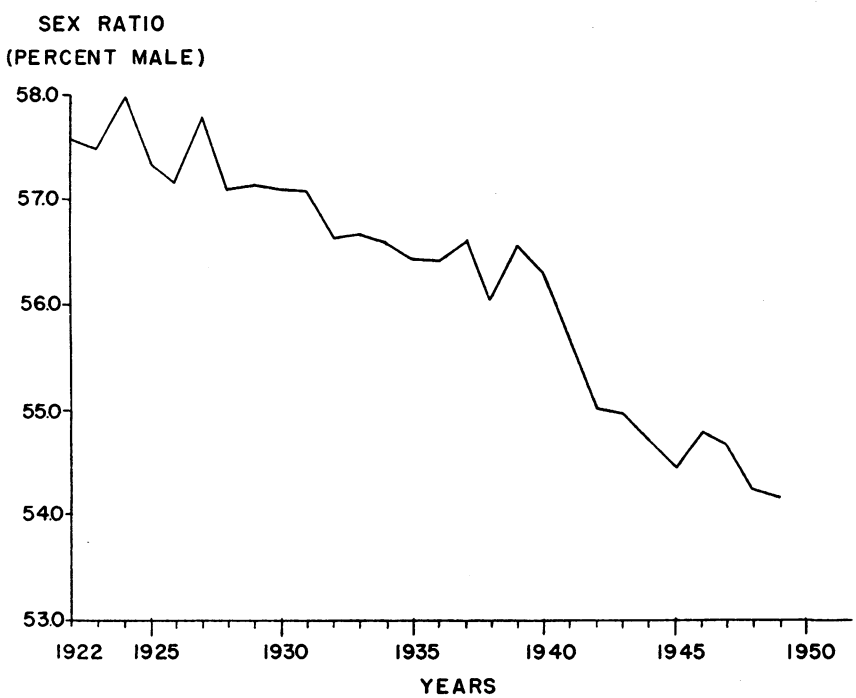

Fig. 1. Sex ratio of white stillbirths, U. S. Birth Registration Area, 1922–49*

* Data on stillbirths by sex are not available prior to 1922.

areas of the United States in respect to completeness of birth reporting, it is clear that the deficiency measured over the country as a whole must be considerable. (2) Although we have been unable to find statistical evidence bearing on the problem, it seems possible that where reporting is incomplete, males may be reported more frequently than females. This supposition receives some support from the fact that non-white live births, reporting of which is also grossly deficient, have shown a similar fall in sex ratio, as judged by national statistics. (3) If in fact under-reporting were associated with a high sex ratio, an improvement in reporting over a period of time would lead to just such a trend in sex ratio as noted here.

Whether the decrease in white stillbirth sex ratio is the result of reporting difficulties or of more directly biological factors it is clear that a long term trend of such a marked nature is likely to obscure changes occurring during a relatively short time period. We have, therefore, limited our examination to livebirths. This is not ideal, since changes in the incidence or sex ratio of stillbirths will affect the sex ratio of total births, stillbirths having a higher sex ratio than livebirths. However, the changes in livebirth sex ratio to be noted in association with the Second World War are abrupt, occurring over a period of three or four years only, and it is difficult to believe that they are appreciably influenced by the long-term trends noted in stillbirths. No such abrupt change either in stillbirth rate or in stillbirth sex ratio occurred in these years. In addition, the contribution of stillbirths to total births is small.

LIVEBIRTH SEX RATIO

In figure 2 is illustrated the sex ratio of all white livebirths in the U. S. Registration Area since its inception in 1915. Sex ratios were generally high in the years 1915–1930, lower in the succeeding 10 years, and high in the five years 1942–46, falling again in 1947–49. The sex ratio in 1946 was the highest ever recorded and that in 1942 was equalled previously only once—in 1925. For the years 1942–46, the sex ratio was 51.481, higher than that for the combined remaining years (51.422) by 0.059 ± 0.016 (critical ratio 3.7), and higher than that for the remaining years in the 20 year period 1930–49 (51.406) by 0.075 ± 0.016 (critical ratio 4.7).

The statistical significance of these differences depends on the large number of births involved, the magnitude of the differences being small. In addition, as pointed out by the Metropolitan Life (1949) there is the suggestion of an upward trend in sex ratio in the pre-war years and the war-time increase may merely be a continuation of a pre-existent trend. However, the interpretation of the meaning of the observations should take into account at least two factors. Firstly, prior to 1933 the Birth Registration Area was constantly shifting its geographical boundaries as states were admitted to and dropped from the Area. It was frequently observed that newly admitted states had high sex ratios. This

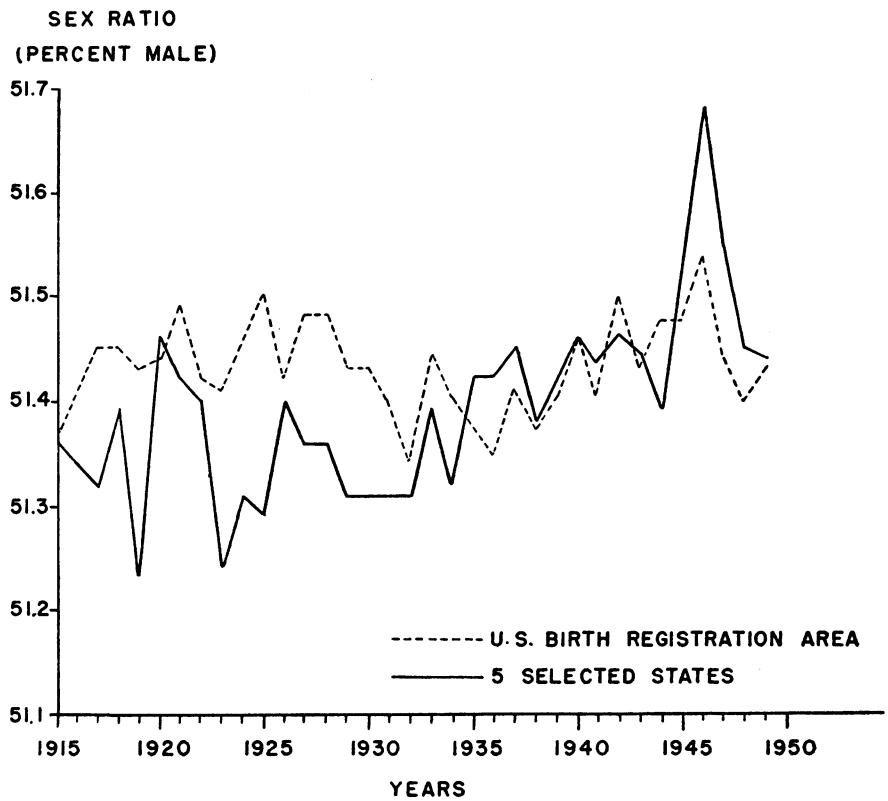

FIG. 2. Sex ratio of white livebirths in the United States, 1915–49

may also have its explanation in the greater completeness of male reporting in under-reported areas. Secondly, within the same geographical boundaries the proportion of births reported has increased progressively over the period considered. These factors may best be taken into account by examination of data for a constant geographical area, this area being selected for completeness of reporting.

There have been two nation-wide estimates of the completeness of livebirth reporting, in association with the censuses of 1930 (Whelpton, 1934) and of 1940 (Grove, 1943). In figure 2 is also given the white livebirth sex ratio in those states having 98% or more of white livebirths reported in both these investigations. There were five such states—Connecticut, Massachusetts, New Jersey, New York, and Rhode Island. The geographical area considered is not entirely constant since the figures exclude New Jersey and Rhode Island, two of the smaller states, for 1920 and the years previous.

The figure shows a high sex ratio in the last year of the war and the following two years. The ratio is again highest in 1946. The contrast between these years

and the preceding years is more marked than that seen for the whole Registration Area since (1) the sex ratio in 1946 is much higher than that for the Registration Area as a whole, and (2) limitation of the examination to these five states has eliminated the high ratios in the period 1915–1930. It is not possible to speculate with confidence on whether these differences are due to the intentional selection in terms of completeness of registration or to the resulting unintentional geographic selection of states lying on the Eastern seaboard. It is clear, however, that, at least in these five states, the end of the second World War saw a marked increase in the sex ratio of white livebirths. It is unfortunate that data for stillbirths by sex are not available separately for these states, but it is inconceivable that either the stillbirth rate or the stillbirth sex ratio experienced so marked and abrupt a change as would be necessary to account for the rise in livebirth sex ratio.

BIRTH RANK AND MOTHER'S AGE

Since sex ratio is believed to vary with age of mother and birth order of child (Ciocco, 1938), changes in the proportions of mothers at various ages and parities are the descriptive explanations most frequently put forward to account for changes in the sex ratio during war (Metropolitan Life 1939; Martin, 1943). We have shown elsewhere, however, that age of mother is without influence on sex ratio when account is taken of the association between maternal age and birth order (MacMahon and Pugh, 1953). It is unlikely, therefore, that sex ratio will be affected by changes in distribution of births by maternal age independent of birth order. The possibility remains that changes in birth order distribution associated with war may influence sex ratio, although in England and Wales such changes were insufficient to account for the observed changes in sex ratio (MacMahon and Pugh, 1953).

Sex ratios by birth rank are not available for the United States for the years immediately prior to 1942, and the question must be examined indirectly. Even for the years subsequent to 1942, the data are not available for individual states and the examination must be confined to the data presented for the United States as a whole in which the period 1942–1946 showed the highest sex ratio. Sex ratio is highest in first births and decreases with advancing birth order. The percentages of first births during 1942–46 and in the preceding five years, 1937–41, were almost identical (38.31% and 38.86% respectively). However, there was a rather lower percentage of births of birth ranks 6 and over in the period 1942–46 than in 1937–41 (7.49% as against 10.02%). If the sex ratios of white livebirths by birth rank for 1942–46 are applied to the known numbers of births in each birth rank in the preceding five years (1937–41), an expected number of male births is obtained which, on addition and application to the total number of births in the same years, gives an expected white livebirth sex ratio for 1937–41 on the assumption that sex ratios of individual birth ranks

TABLE 1. SEX RATIOS OF WHITE LIVEBIRTHS BY BIRTH ORDER, 1942–49

YEAR	BIRTH ORDER			
	1	2	3	4 & over
1942	51.66	51.47	51.40	51.21
	(1,014,372)	(614,047)	(304,780)	(432,000)
1943	51.59	51.49	51.32	51.11
	(945,312)	(694,414)	(355,288)	(473,260)
1944	51.61	51.44	51.52	51.23
	(825,232)	(651,428)	(366,015)	(483,590)
1945	51.57	51.57	51.26	51.29
	(789,167)	(629,966)	(357,947)	(477,254)
1946	51.75	51.52	51.34	51.26
	(1,091,000)	(784,236)	(394,706)	(490,514)
1947	51.59	51.36	51.27	51.29
	(1,340,504)	(859,545)	(427,427)	(492,340)
1948	51.56	51.48	51.11	51.15
	(1,131,375)	(877,977)	(441,005)	(488,400)
1949	51.60	51.43	51.29	56.23
	(1,049,618)	(930,430)	(480,394)	(523,287)
1942–49	51.62	51.47	51.31	51.22
	(8,186,580)	(6,042,043)	(3,127,562)	(3,860,645)

were the same in the two periods. This figure is 51.472, little less than the observed value of 51.481 for 1942–46, and significantly higher than the observed figure of 51.406 for 1937–41 (difference 0.066 ± 0.021, critical ratio 3.1). The difference in sex ratio between the two periods cannot therefore be accounted for by changes in the birth rank distribution of births unless there were coincident changes in the sex ratio within individual birth ranks.

Although no comparable pre-war figures are available, it is of interest to examine the secular changes in sex ratio within individual birth ranks during the years 1942–49. This is done in table 1. In general the sex ratios for the years 1947–49 are lower than the means for the period, irrespective of birth rank. This is further evidence that the high sex ratio for 1942–46 is not the result of changes in birth rank distribution, and also suggests that the rise in sex ratio is not confined to any single birth rank. It is interesting to note however that within the period of high sex ratios (1942–46) individual birth ranks show different patterns. Thus, the high ratios noted in all white livebirths in 1942 and in 1946 are largely the result of high ratios in first births in these years. This is particularly so in 1946, where the sex ratio was outstandingly higher than the mean only in first births. The sex ratio of second births was highest in 1945 and that of third births in 1944.

AGE OF FATHER

Some early writers and more recently Novitski (1953) have suggested that sex ratio may be associated with age of father. Novitski, using United States

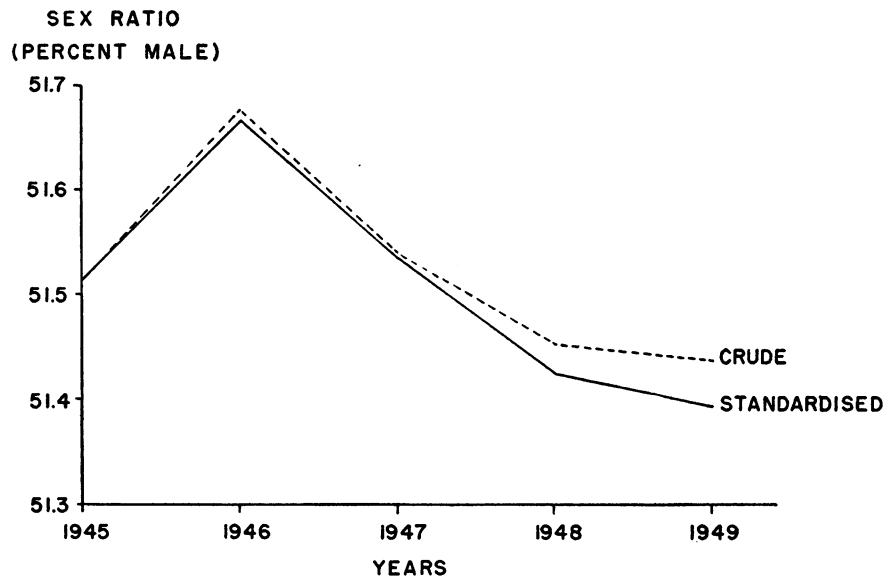

FIG. 3. Sex ratio of white livebirths, five selected states, 1945–49, with standardization for age of father. Standardized against the 1945 distribution by father's age.

Vital Statistics, concluded that sex ratio was more directly correlated with age of father than with age of mother. However, as already noted, age of mother seems not to be important when its correlation with birth order is taken into account. No data are yet available to examine the association with age of father independently of birth order or vice versa.

In attempting to examine the possibility that changes in distribution of births by age of father contributed to the observed secular changes in sex ratio, we are again limited by availability of data. Distribution by paternal age is not available separately for white births prior to 1945, and inclusion of non-white births might seriously bias the examination in view of the lower sex ratio of such births. However, for 1945–49, data on white births are available by age of father and sex and for each state, which makes possible a simple standardization procedure. The distribution of births by paternal age in 1945 in the five well-reported states is used as the standard population, and the sex ratios in each paternal age group in each subsequent year in these states are applied to this standard population. The results are shown in figure 3 and compared with the unstandardized figures shown previously. Certainly in these years and in these states changes in distribution of births by father's age did not contribute materially to the observed changes in sex ratio even though there were appreciable changes in distribution by father's age during this time.

DISCUSSION

These data support the belief that some factor or factors associated with war, or the end of war, influences the secondary sex ratio in man. A belief in the wisdom of Divine Providence in increasing the proportion of males born at such times is not essential to the rationalization of this relationship, although it must be admitted that no more satisfactory explanation is yet available. There is little doubt that the patterns of reproductive practices are disturbed during wartime. That these patterns were particularly disturbed in 1946 (the year of highest sex ratio) is suggested by the fact that the marriage rate of that year (16.4 per thousand) was the highest ever recorded in the United States. At the same time it seems unlikely that the high sex ratio of that year was the result of a high ratio in births resulting from marriages during that year, unless interval between marriage and birth of first child was extraordinarily short. There are no direct data on this question, but the percentage of first births was highest in 1947 which suggests that births in this year felt the greatest effect of the 1946 marriage peak. This is of interest in view of the observation that sex ratio of first births was particularly high in 1946 but not in 1947. Evidently births resulting from marriages occurring before the peak of the post war rush showed the greatest change in sex ratio.

The particularly striking peak of sex ratio in first births in 1946 suggests a more circumscribed population group which seems especially susceptible to this change in sex ratio and in which the explanation of the relationship between war and sex ratio might best be sought.

SUMMARY

Published vital statistics for the United States are used to examine the sex ratio of white livebirths during the years 1915 to 1949 with particular reference to the period of the Second World War. Justification is given for confining the examination to whites and livebirths.

For the Birth Registration Area as a whole there was a small, but statistically significant, increase in sex ratio in the period 1942 through 1946, with the peak attained in 1946. Examination of data from 5 states, (Connecticut, Massachusetts, New Jersey, New York, Rhode Island), in which, both in 1930 and in 1940, 98% or more of white livebirths were reported revealed a more marked increase in sex ratio affecting the years 1945–47, the peak occurring in 1946 being striking. The high sex ratio in 1946 was particularly noticeable in first births.

Evidence is presented which suggests that these secular changes in sex ratio were not the result of changes in distribution of births by age of mother, birth order, or age of father.

REFERENCES

BAUMGARTNER, L., WALLACE, H. M., LANDSBERG, E. AND PESSIN, V.: The inadequacy of routine reporting of fetal deaths. *Am. J. Pub. Health*, 39: 1549, (1949)

CIOCCO, A.: Variation in the sex ratio at birth in the United States. *Human Biol.* 10: 36 (1938).

LOWE, C. R. AND McKEOWN, T.: The sex ratio of human births related to maternal age. *Brit. J. Social M.* 4: 75 (1950).

———— A note on secular changes in the human sex ratio at birth. *Brit. J. Social M.* 5: 91 (1951).

McMAHAN, C. A.: An empirical test of three hypotheses concerning the human sex ratio at birth in the United States, 1915–1948. *Milbank Memorial Fund Quarterly* 29: 273 (1951).

MacMAHON, B. AND PUGH, T. F.: Influence of birth order and maternal age on the human sex ratio at birth. *Brit. J. Prev. Social M.* 7: 83 (1953).

MARTIN, W. J.: Sex ratio during war. *Lancet* 2: 807 (1943).

METROPOLITAN LIFE INSURANCE COMPANY. Statistical Bulletin 20: No. 4, 1. (1939).

———— 30: No. 6, 5 (1949).

NOVITSKI, E.: The dependence of the secondary sex ratio in humans on the age of the father. *Science*, 117: 531.